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THE STUDY OF WATER QUALITY STATUS IN THE NGEBRONG RIVER WITH PHYSICAL AND CHEMICAL PARAMETERS IN THE TAWANGSARI BARAT REGION, PUJON DISTRICT, MALANG REGENCY

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ABSTRACT

Aim: The purpose of this study was to determine the status of water quality in a river by using the Pollution Index method as stated in the Decree of the Minister of Environment No. 115/2003 regarding Guidelines for Determining the Status of Water Quality and to determine the effect of quality status on development efforts towards ecotourism. **Methodology and Results:** The measurement of water quality was carried out at two points, namely T1 (upstream) and T2 (downstream) points. The parameters included BOD, COD, DO, TSS, Temperature, pH, Zn, S, PO_4, NO_3, and NO_2. From the test results for class I, II, and III criteria, almost all parameters exceeded the quality standard. The status of the river water quality, according to the Pollution Index, has increased from moderate polluted upstream and heavily polluted to certain parameters downstream. **Conclusion, significance and impact study:** The quality standards that are met for the river are criteria for class IV. The increase in pollution is indicated by human activity around the river which is characterized by increasing population and land use in agriculture and plantations. The increasing pollution reduces the quality of the river if it is developed into an ecotourism area due to its low water quality status.

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KEYWORDS

- Aquifer artificial recharge
- GIS
- Groundwater
- Infiltration
- Injection well

1. INTRODUCTION

Water is a natural resource widely used for the daily needs of living things. It comes from reservoirs, rivers as well as underground, and must be wisely utilized to avoid contamination therefore its quantity and quality is retained. The Government Regulation No. 82 of 2001 stated that, water is one of the natural resources with very important characteristics for all living things, therefore it is the basic factor of development. Its quality is influenced by land use, lithology, time, rainfall and human activities which most often lead to physical, chemical, and biological pollution (Sheftiana, 2017).

The west of Tawangsari Village, Pujon District, Malang Regency which is approximately 770.04 Ha, is divided into 4 (four) villages, namely Gerih, Manting, Ngebrong and Bunder. Its population is 8,137 and has great potential consideration for Human Resources (HR) and Natural Resources (SDA).

The human activities around Ngebrong River decreases the water quality, therefore, proper management is required to reduce and prevent pollution with adequate monitoring of the activities. Similarly, an evaluation will also be carried out in accordance with the laws and regulations applicable to the region.

Research on the status of the water quality in Ngebrong River is considered important, therefore, appropriate measures can be taken to purify the river when the need arises. The Pollution Index (IP) method is used to determine the water quality of a river using a few data.

2. RESEARCH METHODOLOGY

2.1 Research Sites

This research was conducted at Ngebrong river, Tawangsari village, Pujon district, Malang regency on November 2018. The region is located at the following coordinates 7048'21.6 "LS and 112026'03.0" BT.

2.2 Stage of the Research

The research started with surveying the location, to determine sample points. The steps used in this study are as follows:

1. Location survey

   Location surveys were conducted to determine the region used for this study, and this was carried out by ascertaining the sampling points, observing community activities and land usage as well as by interviewing inhabitants related to the social environment.

2. Sampling

   Sampling is carried out using the Grab Sampling methods after after the survey locations (Efendi, 2003). This is conducted at the upstream (T1) and downstream (T2) points, with 30-50 meters distances from residential settlements.

3. Laboratory Measurement

   This testing was conducted to determine the quality of the water using the following parameters: BOD, COD, TSS, DO, S, PO_4, NO_2, NO_3, Temperature, pH, and Zn.

4. Calculation

   The Pollution Index method was used for computation and it is regulated by the Decree of the Minister of Environment No. 115 of 2003. The procedure for calculating the Pollution Index is explained as follows:

   a) Determining the price of Ci/Lij by calculating the parameter of each location used in determining the concentration of measurement Ci results and the quality standard of water Lij in accordance with PP No. 82 of 2001.

   b) If the value of the parameter concentration decreases, the pollution level increases . This is written in the equation as follows:

$$\frac{Ci}{Lij} = \frac{Cim - Ci(result)}{Cim - Lij} \quad (1)$$

   If the quality standard for Lij has a range, then the equation is as follows:

   - Cij < Average score is used

$$\frac{Ci}{Lij}(new) = \frac{[Cj - Lij(average)]}{[Lij(minimum) - Lij(average)]} \quad (2)$$

   - Cij > Average Lij is used

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$$\frac{Ci}{Lij}(new) = \frac{[Ci - Lij(average)]}{[Lij(minimum) - Lij(average)]} \quad (3)$$

When Ci/Lij are close to the reference value of 1.0, for example C1/L1j = 0.9 and C2/L2j = 1.1 or very large differences, for example C3/L3j = 5.0 and C4/L4j = 10.0, the methods used to overcome this are:

a) Use the value (Cij/Lij) of the measurement results if the value is < 0

b) The use of a new value (Ci/Lij) if the value (Ci/Lij) has a result greater than 1.0 with the calculation of the value (Ci/Lij) with the following equation:

$$\frac{Ci}{Lij}(new) = 1 + P\ Log\ \frac{Ci}{Lij} result \quad (4)$$

Where P is the constant and the value is determined to be free and adjusted to the results of fund's environment observations, and know the requirements that have been applied to an allocation (usually by using a value of 5).

c) To determine the average and maximum values of the overall Ci/Lij [(Ci /Lij) R and (Ci/Lij) M].

d) Pricing of IP or Pij using the equation:

$$Pij = \frac{\sqrt{\left(\frac{Ci}{Lij}\right)2M + \left(\frac{Ci}{Lij}\right)2R}}{2} \quad (5)$$

The criteria for water quality by using the Pollution Index method can be seen in Table 1 below.

Table 1 Classification of Water Quality Criteria for the Natural Science Method (Kepmen LH No. 115/2003)

The value of pollution index	Condition
0 ≤ Pij ≤ 1.0	Fulfil the standard quality (good condition)
1,0 ≤ Pij ≤ 5.0	Minor pollution
5,0 ≤ Pi j≤ 10	Medium pollution
Pij ≥ 10	Heavy pollution

5. Management of Activities and Land Use

   Land usage is analysed using the information from the community's activities. This information will be used as a consideration in making an ecotourism region and determining the effect of these activities on river water quality. In developing ecotourism region, it is necessary to suit the function of the land with community activities, therefore, the sustainability of the region is maintained.

6. Community or Social Environment Interviews

   This is a form of data collection technique used in qualitative research. Interviews with the community or social environment aim to obtain information on social data, age, education, gender, type of work and tourist region.

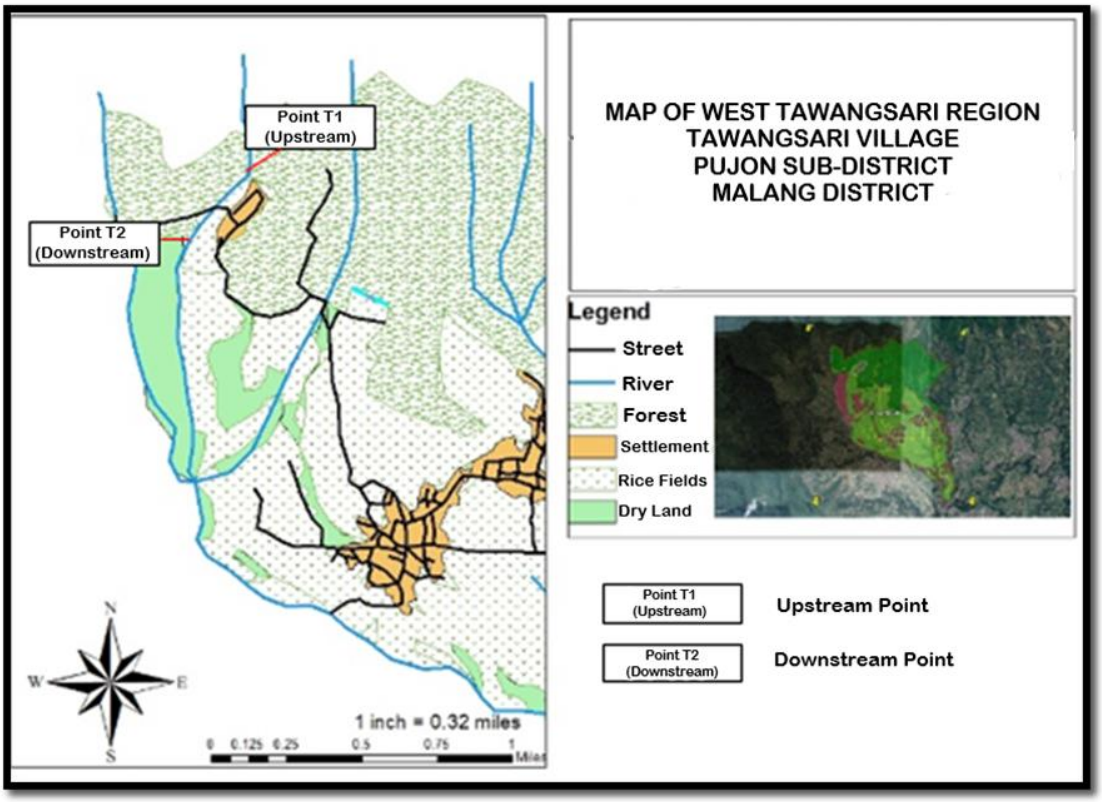
7. Management Strategy

   Two aspects that need to be considered in ecotourism include destination and market. Environmental-oriented ecotourism development is far more guaranteed as it tends to compare growth sustainability. A good strategy to maintain water quality is so that it is free from pollution is by proper management strategy.

3. RESULTS AND DISCUSSION

3.1 Research Location

This research was in Ngebrong Village, Tawangsari Village, Pujon Subdistrict, Malang Regency. The sampling location is at an altitude of ± 1,219 masl with location coordinates of 7048'21.6 "LS and 112026'03.0" BT. Its administrative map can be seen in Figure 1 below:



(Source: Google Earth, 2018)

Figure 1 Map of the administration of Ngebrong Hamlet

3.2 Water Quality of the Ngebrong River

Eleven parameters are used to determine the water quality, this comprises of Temperature, pH, TSS, BOD, COD, DO, S, PO_4, NO_2, NO_3, and Zn. Its standard is in accordance to Government Regulation No. 82 of 2001 Management concerning quality and pollution control. Table 2 shows the tested quality of the river as follows:

Table 2 Quality of the Ngebrong River

Parameter	Sampling point		The standard quality for Class IV
	T1 (Upstream)	T2 (Downstream)	
Dissolved Oxygen (DO) (mg O_2/L)	5.0	5.2	0
Biological Oxygen Demand (BOD) (mg/L)	8.38	7.12	12
Chemical Oxygen Demand (COD) (mg/L)	21.39	21.75	100
Total Suspended Solid (TSS) (mg/L)	8.4	6.0	400
Nitrate (NO_3) (mg/L)	1.491	2.993	20
Nitrite (NO_2) (mg/L)	0.0269	<0.0022	0.06
Total Phosphate (PO_4) (mg/L)	0.1796	0.5095	5
Sulphur (S) (mg/L)	<0.0128	0.0650	0.002
Zinc (Zn) (mg/L)	<0.0066	<0.0066	2
Temperature (°C)	20.3	21	deviation 5
Acidity (pH)	7.75	7.82	5-9

Source: Results of Testing of PJT Environmental Laboratarium Malang, 2018

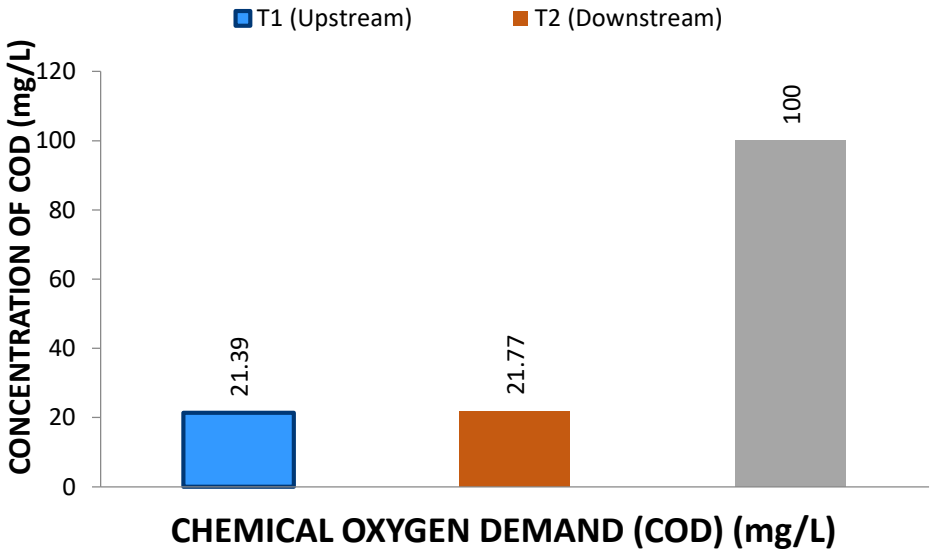


Figure 2 COD

Based on the data obtained, it is known that some parameters exceed the standard quality for class IV. Based on Figure 2, higher COD concentration at T2, shows that the organic content cannot be degraded biologically (Dewa *et al*., 2016). In Figure 3, the BOD concentration at T1 is higher than T2 which indicates that the Ngebrong River has poor water quality owing to the

high levels of organic waste (Dewa *et al*, 2016).

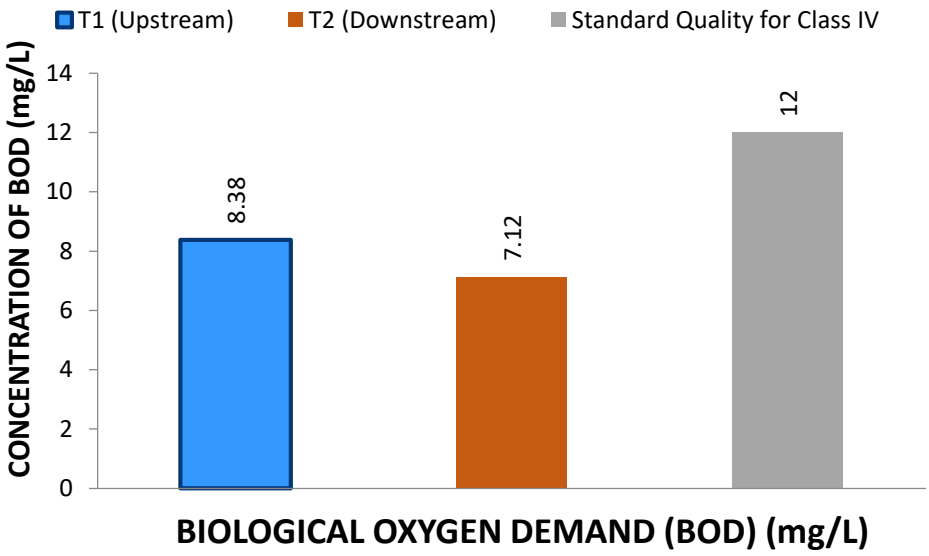


Figure 3 BOD

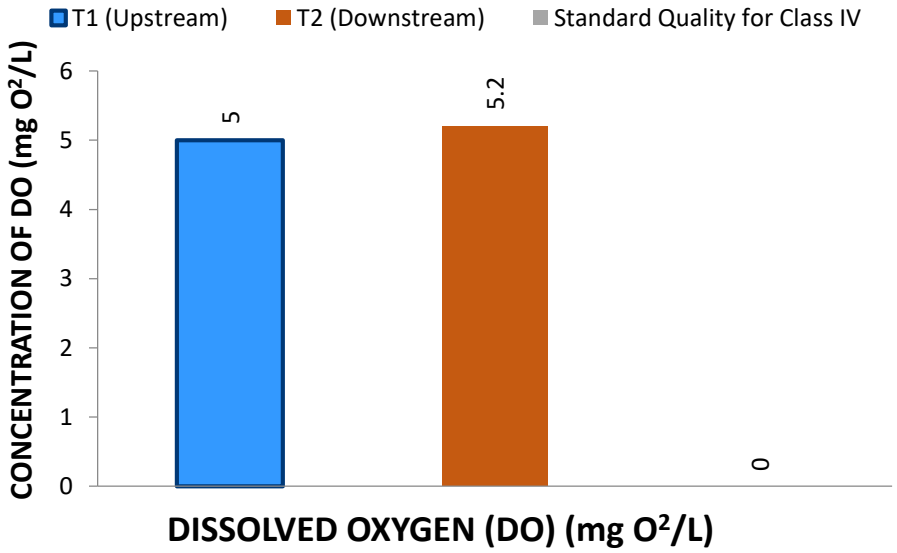


Figure 4 DO

Based on Figure 4, the Dissolved Oxygen concentration at T2 is better than T1. According to Nasution (2010), Dissolved Oxygen is an important parameter owing to its ability to indicate the level of pollution/waste treatment. The high concentration of DO at the T2 is because there are

many large trees on the right and left sides. It also originates from air diffusion and the results of photosynthesis of organisms living in water. In Figure 5, TSS at T1 is higher than at T2. Moreover according to Siswanto (2010), high TSS concentrations were found in the estuary region of the river and along the coast with greater sedimentation.

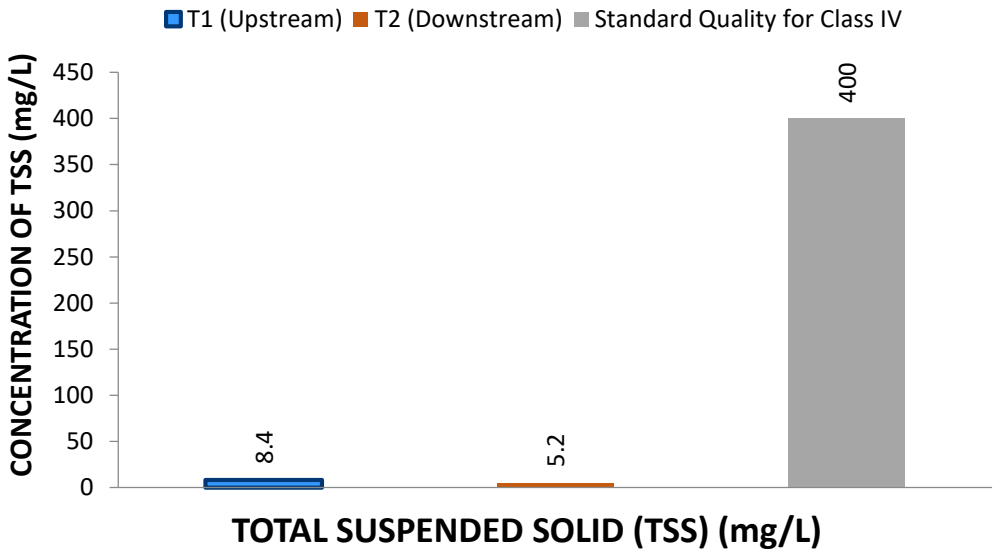


Figure 5 TSS

In Figure 6, the Temperature at T1 is lower than T2. High water temperatures are caused by the high intensity of sunlight (Marlina *et al.*, 2017). In Figure 7, pH concentration at point T1 is lower than T2 owing to the fluctuations in O2 and CO2 content (Rukminasari, *et al*., 2014) and due to the abundance of chemical compounds.

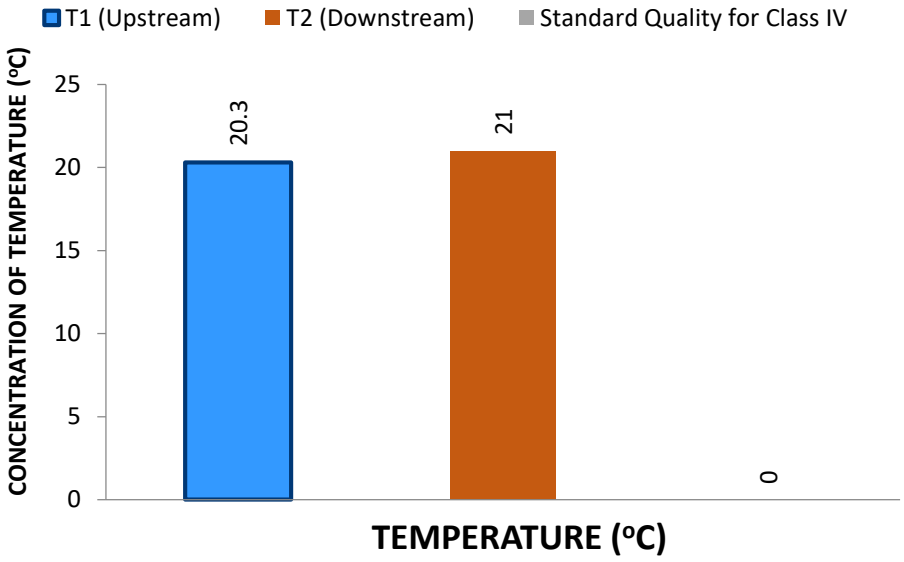


Figure 6 Temperature

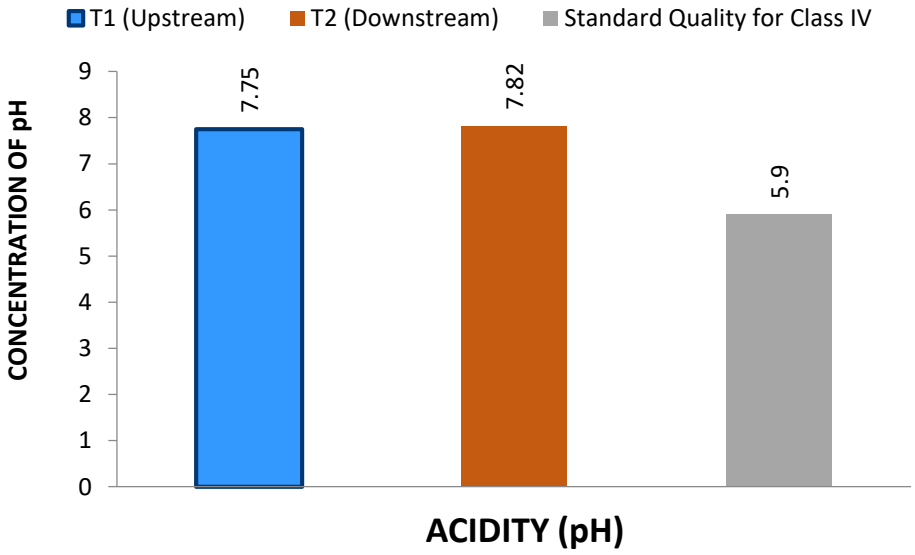


Figure 7 pH

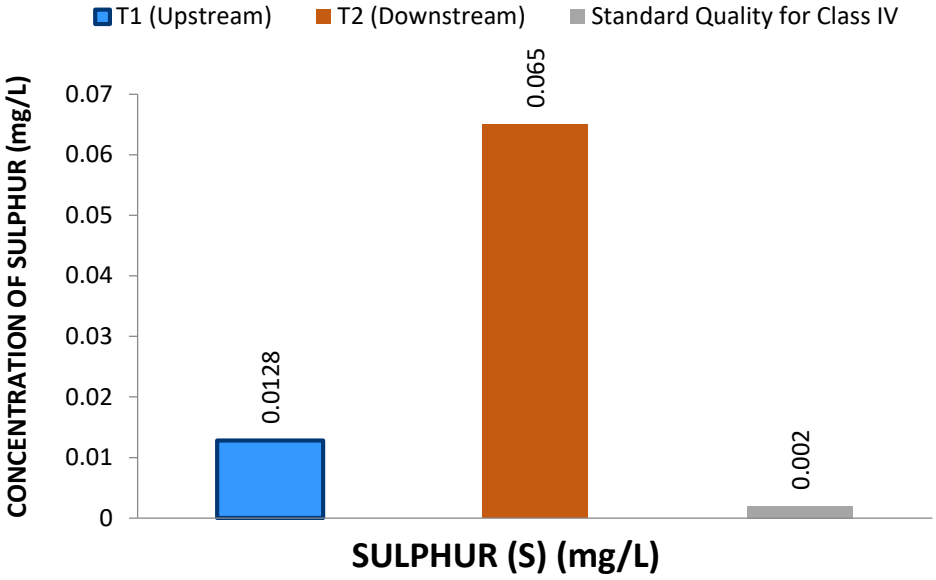


Figure 8 Sulphur

Based on Figure 8, the highest sulphur is in the upstream. It is one of the essential elements needed by plants. It is absorbed as sulphate ions and reduction in the upper soil. It is mostly influenced by irrigation, air, fertilizers, insecticides and fungicides (Mashtura *et al*., 2013).

As for Figure 9, it can be seen that the highest Total Phosphate is found in the T2. This is due to domestic waste from settlements which affects the Total Phosphate concentration at T2. The presence of excessive Total Phosphate in water bodies leads to nutrient eutrophication/enrichment (Masduqi, 2004).

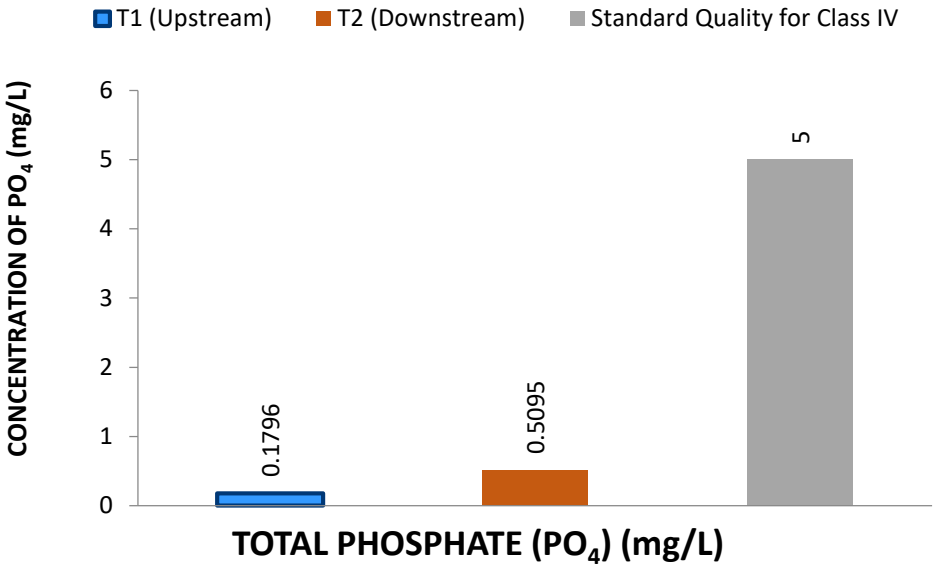


Figure 9 Total Phosphate

In Figure 10, the Nitrate concentration at T2 is higher than T1 and influenced by pollution of chemicals such asurea, ZA and others (Herlianti *et al.*, 2016). In Figure 11, the concentration of Nitrite (NO_2^-) at T1 is higher than T2 owing to increase in number of organic materials. Decomposition by microorganisms requires large amounts of oxygen, which can also be extracted from nitrate compounds (Hendrawati, 2008).

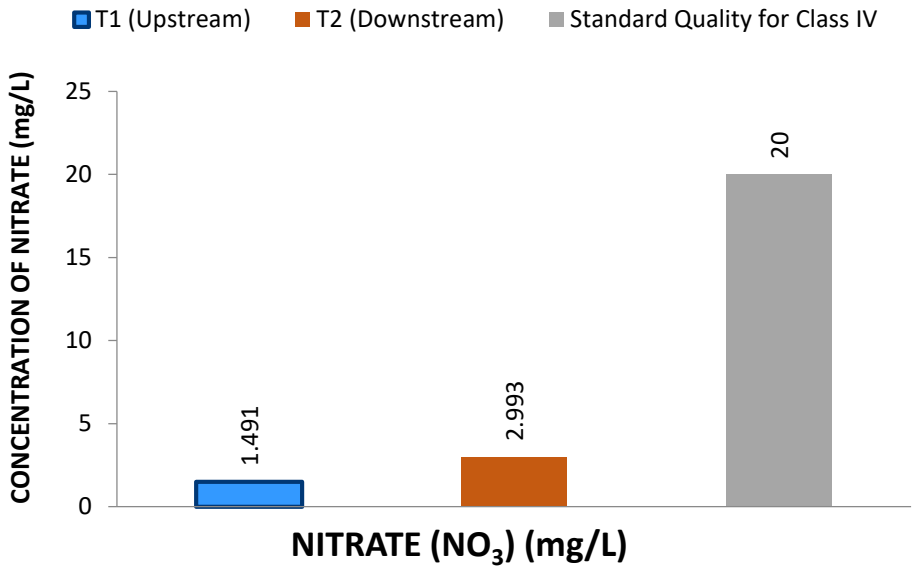


Figure 10 Nitrate

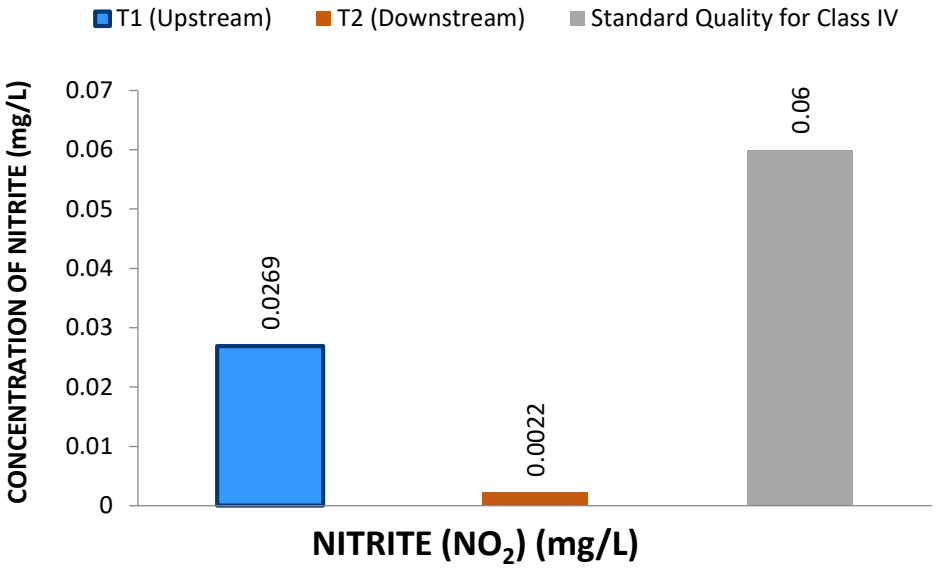


Figure 11 Nitrite

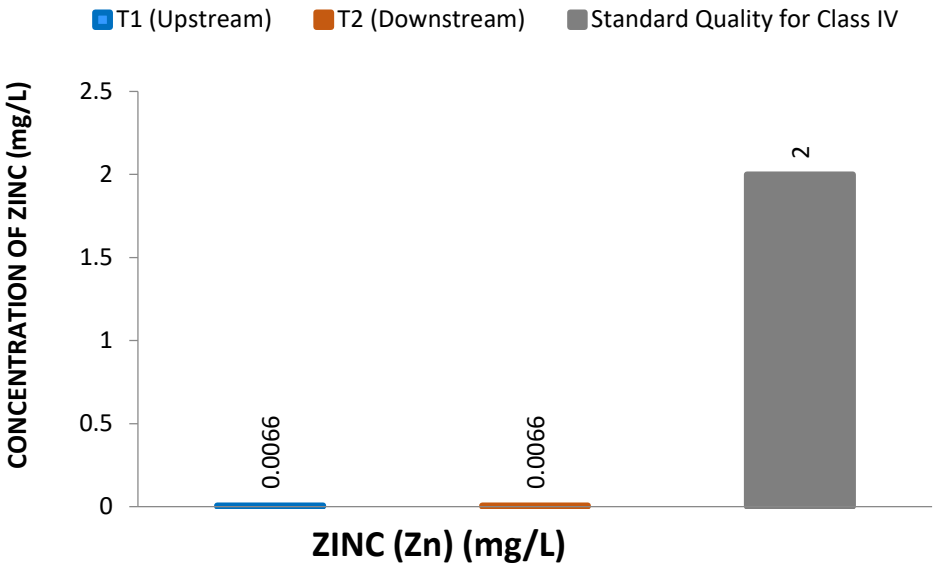


Figure 12 Zinc

Figure 12 is a graphical image of the Zn concentration with no difference at point T1 and T2. If its presence in water exceeds the standard limit, it can be detrimental to human health.

Based on the data above, it is known that the Ngebrong River water quality meets the fourth grade standards according to PP No. 82 of 2003, although it is above the value in class IV quality. The results are listed in Table 2 as follows:

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Table 2 The flow of Ngebrong River water

Monitoring Location	Debit (m^3/s)
T1 point (upstream)	2.983 m^3/s
T2 point (downstream)	5.9892 m^3/s

The discharge at the T2 is greater than the T1 with the size of the flow rate influenced by the condition of the river body. In addition, the amount of discharge is owing to the fact that the width and depth are greater than the cross-sectional region. Input of surface runoff and groundwater from infiltration through plant roots around the study site also affected the amount of flow rate.

3.3 Determination of the Status of Water Quality

This is carried out using the Pollution Index method which is based on the Decree of the Minister of Environment No. 115 of 2003. Calculations are carried out on the parameters of TSS, BOD, COD, DO, NO_2, NO_3, Zn, PO_4, and S. It indicates water conditions at a certain time in comparison with the specified quality standard (KLH, 2003). Table 3 is the Ngebrong River water quality status that has been calculated by using the Pollution Indicator Method.

Table 3 Status of water quality of the Ngebrong River

Location	The value of Pollution Index	Standard Quality Status
T1 point (upstream)	4.5455	Medium pollution
T2 point (downstream)	23.0601	Heavy pollution in the certain parameter

Based on Table 3, T1 point is moderately polluted because the concentration of S at the location is six times above the standard quality thereby inhibiting various parameters in the presence of the S compound, while T2 is heavily contaminated with certain parameters.

Figure 13, is a pollution index graph at T1 and T2. A high pollution index at the T2 makes the location heavily polluted. The influence given by the entry of domestic waste into the river body is quite large. The domestic waste results in increased concentration in several parameters such as the S.

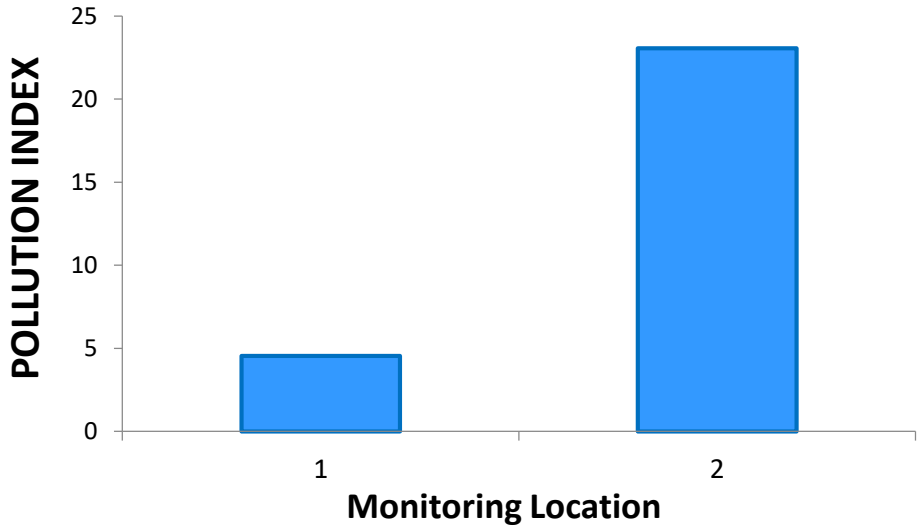

Figure 13 Bar diagram of the Ngebrong River water pollution index

3.4 Feasibility Determination for Ecotourism Areas

Ecotourism is a form of tourism that emphasizes more on preserving nature, providing benefits and economy and maintaining cultural integrity for the community (Muhajirin, 2015). In addition, to utilizing existing natural resources into tourist regions, it also conserves the environment, thereby, leading to the preservation of species and habitats by the local community (Sastrayuda, 2010).

According to Sastrayuda (2010) ecotourism relies on natural and cultural environments relatively unpolluted or disturbed, with the ability to provide direct ecological, social and economic benefits to the local community.

The concept of ecotourism development is to increase public awareness on the environment which raises various demands in all development sectors. This indirectly encourages the growth of businesses and various activities to improve the living standard of the local community.

Based on the principles and concepts of the approach previously described, the Ngebrong River actually developed into an ecotourism region, however, several factors are required. For instance the water quality did not meet the standard of class II which according to PP No. 82 of 2001, in order to name it a recreational center. Based on calculations using the Pollution Index Method, T2 the river is heavily polluted. This is caused by the upstream part being located

between the plantation and the river. With this, all organic and inorganic compounds from the plantation land enter into the river body. Fertilizers and pesticides from plantation land are carried by the flow of water, resulting in high levels of sulphur.

4. CONCLUSION

Based on the research conducted on the study with physical and chemical parameters in the west of Tawangsari Region, Pujon District, Malang Regency using the Pollution Index method, the following conclusions were obtained:

a) Ngebrong River water quality based on PP No. 82 of 2001 at T1 (upstream) and T2 (downstream) point S have grappled class IV standards on all parameters except the Sulphur (S) which is 0.0650 mg/L.
b) The relatively small river is influenced by the topography and conditions of the season. The discharge at T1 (upstream) point is 2.983 m3/s and 5.9892 m3/s at T2.
c) The status is polluted with an index of 4.5455 and 23.0601. This indicates that domestic and plantation waste affect the quality of water at the study site.
d) The water quality that enters class IV cannot be used as a river-based ecotourism region because it is not in accordance with its designation.

Based on conclusions and research conducted, suggestions can be made consisting of several points, as follows:

a) For further study, other methods such as the STORET and bio-monitoring techniques can be utilized with macro-invertebrates.
b) It is necessary to restore the quality of the Ngebrong River, therefore, it can be utilized according to its designation.
c) For the community, it is better to maintain the cleanliness and preservation of the environment around the river, in order to create good sanitation.

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